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PHARMACY BENEFIT MANAGERS AND VERTICAL RELATIONSHIPS IN DRUG SUPPLY: STATE OF CURRENT RESEARCH

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ABSTRACT

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Pharmacy Benefit Managers and Vertical Relationships in Drug Supply: State of Current Research *

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April 12, 2022

Abstract

Despite their importance to the supply of prescription drugs, there has been limited research on pharmacy benefit managers (PBMs) and their vertical relationships to insurers and drug manufacturers. This paper provides an overview of the current state of research on this topic, motivates why further research is needed, and discusses promising theoretical and empirical directions for that research.

1 Introduction

Policymakers have been concerned for some time about high prices across different health care areas, including hospital prices, drug prices, and physician fees. There is substantial recent interest in finding ways to lower prices through policymaking, with one point of emphasis being lower drug prices (see, e.g., this recent house antitrust subcommittee hearing).

Drug prices account for 10% of U.S. health care spending but many economic aspects of drug supply are not well understood. Recently, the CBO completed a study comparing drug prices across different government programs with an emphasis on the intricacies of the vertical supply chain, i.e. the relationships between drug manufacturers, pharmacy benefit managers (PBMs), insurers, and consumers. Despite the importance of understanding the impact of the drug supply chain on final drug prices and quantities, it has

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been limited theoretical or empirical analysis to date modeling the effects of market structure and mergers on these key outcomes. This has made it difficult for policymakers to draw on clear and precise evidence when assessing, e.g., the impact of vertical mergers between PBMs and insurers or, e.g., the impact of consumer drug access regulations on key drug market outcomes.

More broadly, policymakers have been concerned about the potential role that PBMs play in driving up drug prices in the market. PBMs serve many different functions, but their primary economic function, and what we focus on here, is to negotiate with drug manufacturers and establish (potentially restricted) formularies for insurers to use downstream. PBMs negotiate with drug manufacturers to obtain rebates off of drug list prices in return for including their drug(s) on their formulary. If no deal is reached, the PBM will not include the drug on the formulary and consumers purchasing an insurance plan with that formulary will not be able to access that drug under their insurance plan. PBMs offer their formularies to insurers downstream who agree to place restrictions on consumer drug use in return for lower drug prices. The PBM may pass through only a portion of the rebate to the insurer, keeping some of the rebate as profit.[1]

Why do PBMs exist as intermediaries in this market, when insurers could perform many PBM functions on their own? When insurers began to cover prescription drugs in the 1960s, managed care tactics were not very common and most insurance plans operated as indemnity plans that provided coverage for any provider and any service. Many on-patent drugs were (and still are) supplied by providers that have significant, often monopoly, market power. PBMs arose as a response to this market power by drug manufacturers, creating entities that aggregated demand from different insurers into larger units that had more clout to negotiating drug prices. As managed care has become the norm over time, PBMs have continued to serve this central function of negotiating drug prices. If drug manufacturers don't deliver high enough discounts, PBMs place drugs on lower formulary tiers or exclude drugs entirely, giving manufacturers limited access to the customers that PBM clients serve. The recent movement towards integration between PBMs and insurers (more details below) results from the fact that, over time, insurers have been larger and more sophisticated in their tactics. This has led to an environment where insurers have more capacity and interest as organizations in integrating functions that had previously been outsourced, especially in cases like PBMs where larger insurers stand to gain significantly from bringing these functions in house, leading to more effective internalization of pricing incentives through the drug supply chain. For greater details on the evolution of PBMs, see Kwoka and White (2019) and for a theoretically-motivated discussion of why PBMs

[1] See Kwoka and White (2019) for an in-depth economics-motivated discussion of PBMs and their associated institutions.

exist see Conti et al. (2021), which we discuss in more depth later.

With this high-level overview of PBM functions in mind, it is useful to give some more details on exactly how funds flow in the drug supply chain. This helps understand both the key functions PBMs serve as well as why vertical integration may be attractive for insurers and PBMs. The figure shows, e.g., how in the typical non-integrated setup, insurers have both direct and indirect interactions with PBMs. Directly, insurers supply payments to PBMs in return for managing their drug benefits, including formulary specifics. The PBM passes through a share of rebates received from manufacturers to the insurer, as a function of the number of customers who have used on-formulary drugs. Apart from these direct interactions with each other, PBMs and insurers do many things that indirectly interact with each other. Insurers charge premiums and provide drug coverage to consumers. PBMs negotiate with drug manufacturers over rebates, formulary placement, and other performance incentives. PBMs pay for drugs from pharmacies, building on these negotiated agreements, and receive copayments from consumers. As this figure illustrates, PBMs and insurers have a lot to potentially gain from aligning their incentives including (but not limited to) (i) better integration between medical and pharmacy incentives and benefits (ii) reduced "double marginalization" issues from multiple contracting layers through the drug supply chain and (iii) direct integration between drug pricing and premium pricing in downstream insurance markets.

Figure 2 shows a breakdown of nationwide PBM market shares, sourced from this recent report. This figure underscores policymakers concerns about market concentraion and rent-seeking by PBMs: the top three PBMs have a 79% share of the downstream drug market, a level of market concentration that would typically alarm antitrust authorities. Morever, the top 3 PBMs by market share are all vertically integrated with a large downstream insurer: Caremark with CVS/Aetna, Express Scripts with Cigna and OptumRx with United. While a 79% C3 would be concerning in a purely horizontal market structure, it is well known in antitrust economics that assessing policies in industries with important vertical relationships is challenging (see, e.g., Whinston (2006) or Slade (2021)). Even in the presence of reliable data, how vertical relationships affect consumer welfare is generally theoretically ambiguous, and under various models of supplier behavior, stronger vertical relationships can greatly improve consumer welfare or greatly harm it. This has made it challenging for policymakers to assess whether the level of market concentration in the PBM space and the vertical relationships between the largest PBMs and large insurers are cause for concern or actually a driving force keeping drug prices lower than they would otherwise be.

Figure 3 presents a stylized representation of the drug vertical supply chain, cutting out some important

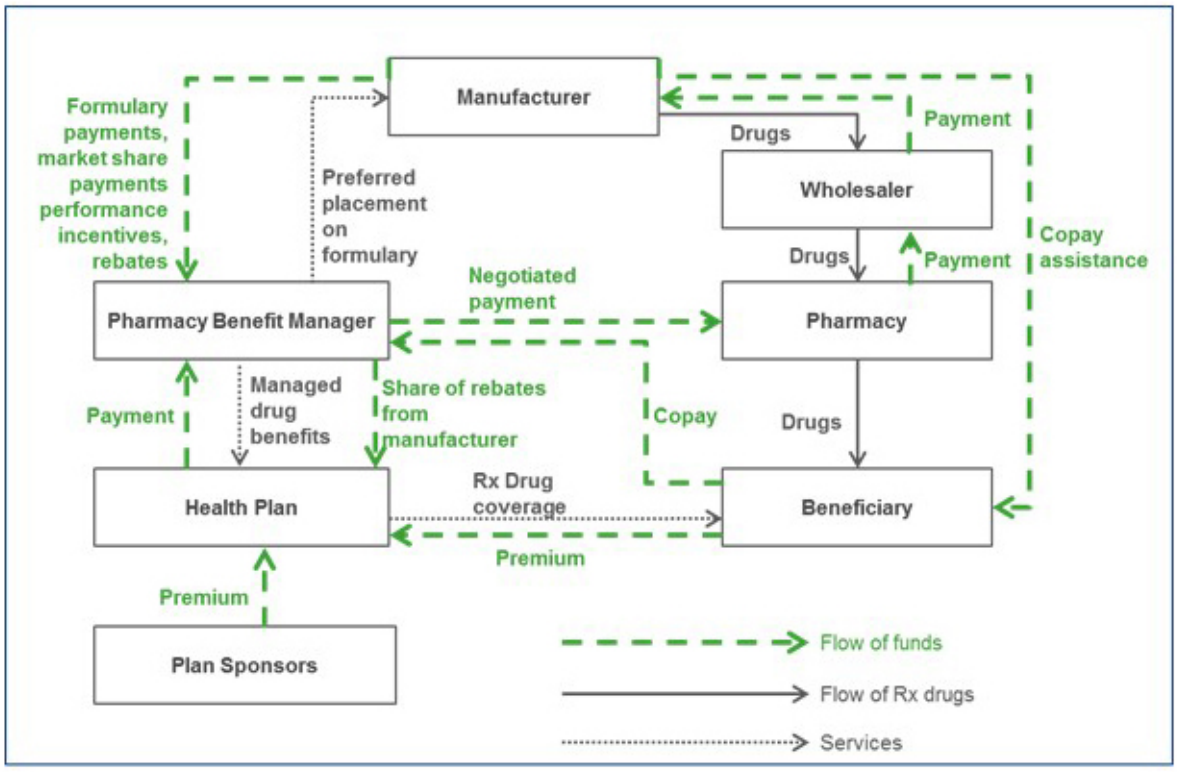

Figure 1: Diagram highlighting fund flows in the drug supply chain, with a focus on the role played by PBMs. Source is Sood et al. (2017).

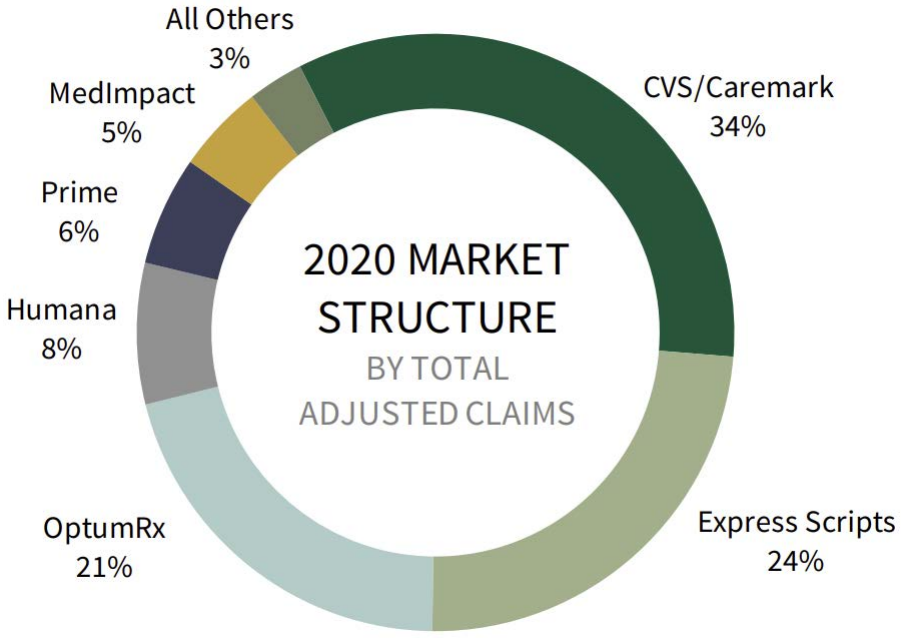

Figure 2: Market shares by PBM in the U.S.

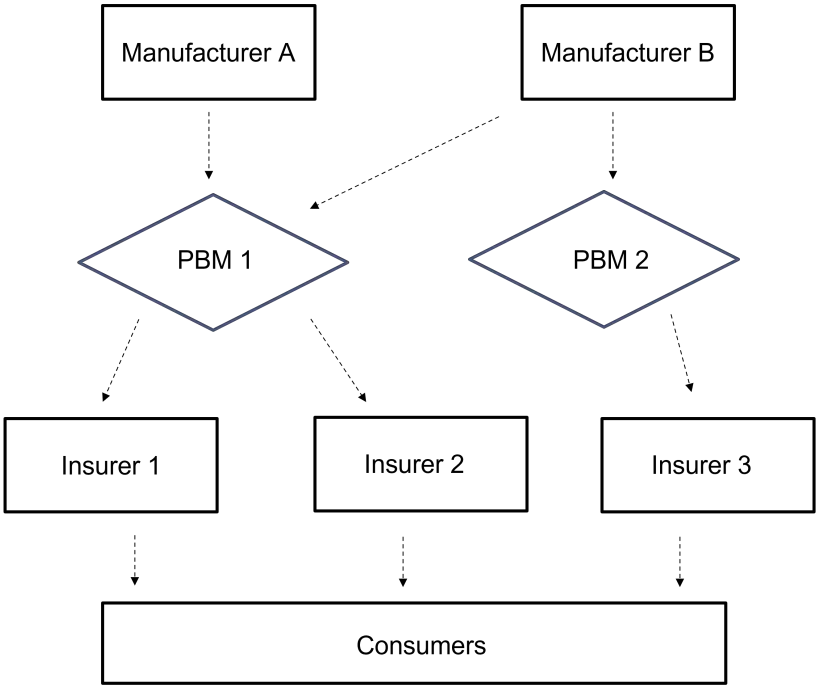

Figure 3: Stylized diagram of industry structure in drug supply chain.

actors (e.g. pharmacies and wholesalers) for parsimony. PBMs can and typically do have relationships with many drug manufacturers and many insurers. As is typical in vertical industries, interactions downstream (e.g. between consumers and insurers and insurers and PBMs) impact interactions upstream (e.g. between PBMs and drug manufacturers). In order to effectively understand the impacts of policies in this kind of market, it is important to have a notion of market equilibrium where all businesses (and consumers) are strategic and best respond to the actions of other agents in the vertical supply chain. The ambiguity of the welfare impacts of market concentration in vertical industries coupled with the inherent complexity of the drug supply chain have made it especially challenging for researchers to assess the impacts of policies that impact market structure (e.g. blocking a vertical merger between a PBM and an insurer) as well as to assess the impacts of policies that ostensibly target one part of the supply chain (e.g. requiring insurers to partially cover some drugs) but whose effects may ripple through the supply chain upstream.

In addition to these conceptual and institutional difficulties, a third reason for limited research in this space is that there is limited data on some of the most important interactions in the supply chain. As B2B firms, the contracts PBMs sign with their clients need not be revealed publicly, and thus it is difficult to know, except in vague terms, what sort of rebates they are negotiating, and how much of those rebates

are passed on to insurers and consumers. In practice, PBMs are notorious for closely guarding data on rebates, to maintain a competitive advantage relative to other PBMs in both upstream negotiations with drug manufacturers and downstream negotiations with insurers. While some recent research has made progress identifying average rebates for specific drugs at the national level (e.g. Kakani et al. (2020)) researchers have still generally not gained access to datasets that provide information on specific PBM-drug rebates and the extent to which those rebates are passed through from specific PBMs to specific insurers. While there is now a substantial body of research modeling downstream consumer demand for drugs and insurance products, these key upstream data pieces are essential complements to applied theory to understand the impacts of the myriad policies being discussed in this space.

In this paper we aim to provide an overview of economic research to date on the industrial organization of drug supply with a focus on the interactions between drug manufacturers, PBMs, insurers and consumers. First, we review some work to date that makes progress in constructing useful economic models of the sector and, in some cases, uses available data to empirically analyze specific issues. We highlight progress to date while noting that there is limited work to date and that substantial progress in both economic modeling and data availability seem essential for reaching a point where we can credibly conduct analyses of vertical market structure and policies like regulation that requires a minimum standard for drug coverage for some drugs.

After assessing the current literature, we provide an illustrative example from our recent research (Brot-Goldberg et al. (2022)) modeling this vertical industry. We model interactions between drug manufacturers, PBMs, insurers and consumers in a vertical setup where all actions and strategies are interrelated. Relative to prior work, the model develops a richer notion of interactions between PBMs and insurers, which helps flesh out some key implications of vertical market structure. We show how the model can be used to (i) assess the implications of vertical mergers and (ii) assess the implications of a policy that requires insurers to cover all drugs in a sector at some minimum rate greater than 0. These illustrative examples highlight how applied economic modeling can be further used to better our understanding of dynamics in this sector and also presents the kind of detailed framework that may be a useful complement to more detailed data.

After providing this illustrative example, we discuss the current state of data and potential paths for collecting and accessing better data in this space going forward. While much can still be learned with existing data, more detailed applied economic models of the kind illustrated in this paper are complements to more granular data and moving forward on both dimensions simultaneously is important for making rapid

but rigorous contributions to the policy debates on drug access and pricing.

While reading this paper, it is important to keep in mind that, as we move towards accessing richer data and performing more sophisticated empirical research in this space, that drug supply is multi-faceted and key institutional details may vary with both the market being considered (e.g. large employer markets vs. Medicare Part D) as well as with the kind of drug being considered (e.g. specialty drugs vs. non-specialty drugs, generic vs. branded).[2] [3] It is more likely that research progress will occur for publicly regulated markets (e.g. Medicare) where data access should be more centralized and the institutional details surrounding business-to-business relationships may be clearer. With this in mind, researchers will want to be careful in appropriately defining markets and understanding the institutions within each specific market segment. Our overview presented here is stylized in the sense that it takes a high level view of the issues in this space, but specific studies will need to be cognizant of the exact institutions and players in this part of the market being studied.

2 Existing Knowledge: PBMs and Market Structure

The positive and normative implications of market structure in vertical industries are generally more difficult to assess than in industries with primarily horizontal market structures (see, e.g., Whinston (2006) or Slade (2021)). Even in the presence of reliable data, how vertical relationships affect market share, costs, and consumer welfare is often theoretically ambiguous: for example, under various models of supplier behavior, stronger vertical relationships could greatly improve consumer welfare or greatly harm it. Lee et al. (2021) survey theoretical and empirical work on vertical industries and note that, in addition to the greater theoretical ambiguities relative to horizontal analyses, the empirical burden for researchers studying vertical markets is often higher both because (i) institutional details are often more complex and because (ii) obtaining reliable data on all relationships in the vertical supply chain can be quite challenging, especially for business to business interactions.

With these challenges in mind, existing work on PBMs has largely focused on specific slices of the vertical supply chain, holding the interactions in other parts fixed. At the top (upstream) part of the supply

[2] Specialty drugs are very expensive on average and may be a special focus area for PBM profitmaking. Since PBM can earn additional profits in this space by securing wholesale cost discounts to their pharmacies, rather than via rebates, this area presents some additional economic issues of interest that we can study in the context of our model described above.

[3] 'High-cost' generic drugs seem to have high spreads between retail prices and wholesale costs, signaling a meaningful impact of market power coming from the PBM part of the vertical supply chain.

chain, recent research by Agha et al. (2020) studies how PBM market power and subsequent purchasing tactics impacts pharmaceutical innovation. This study establishes up front that (i) the PBM sector is highly consolidated and (ii) that over the past decade PBMs have increasingly excluded drugs for formularies when reasonable alternatives to those drugs exist. This paper uses data on Medicare Part D formularies and drug development to show that, when PBMs increased the extent of formulary exclusion for drugs with close substitutes, innovation and drug development decreased in categories more prone to exclusion (those with fewer existing therapies but large potential market size). While it is ambiguous whether shifting innovation patterns in this way is good or bad from a consumer welfare standpoint, establishing the direct link between PBM behavior and innovation is an important ingredient into understanding the overall impact of PBM integration and market power on positive and normative outcomes in the vertical drug supply chain.

Several other recent papers take drug innovation as given but focus on studying bargaining between drug manufacturers and PBMs, conditional on the set of available drugs. Feng (2021) collects data on negotiated PBM-manufacturer payments in the anti-cholestoral statin market from 1996-2013 and seeks to answer whether the presence of PBMs in this market generate value to consumers. The paper specifically seeks to investigate the impact of PBMs on (i) downstream drug costs paid and (ii) drug formulary exclusion, to get a sense of how large in magnitude effects are on these key outcomes. Feng's analysis shows that PBMs reduce overall spending by about 15% (total downstream drug costs), reduce drug company profits by 25%, and take back some of the reduced downstream rebates for their own profits. The paper finds that, even though formulary exclusion does restrict access somewhat, that in equilibrium these reductions in access are small and that the reduced downstream drug costs are achieved primarily via the threat of formulary exclusion rather than through actual exclusion. This suggests that, in the drug context studied, PBMs increase consumer welfare. It is important to point out that the Agha et al. (2020) paper shows that formulary exclusions pick up rapidly after 2012, right at the end of the Feng (2021) data. This suggests that the conclusions of the latter study could change if performed with more recent data.

Conti et al. (2021) set up a model that focuses on understanding several mechanisms for why PBMs might exist as intermediaries and links these mechanisms to their potential welfare implications. The paper assumes that a monopolist PBM can serve as a common agent (for many downstream payers) that negotiates rebates with upstream drug manufacturers in return for placement on a preferred drug tier downstream. The authors structure the formulary negotiation as an all-pay contest where the manufacturer pays a fee (rebate) to ensure they are not frozen out of the downstream market through poor tier placement (or exclusion).

A key goal of the paper is to understand why PBMs exist at all. One could easily imagine that downstream payers don't need an intermediary to negotiate formularies on their behalfs and that they could perform those negotiations themselves. The Conti et al. (2021) studies the case where payers negotiate directly with manufacturers and the alternative case where the monopolist PBM act as a common agent for all payers. First, they show that in their model, having formularies at all is efficient in the sense that, in their equilibrium only one drug is excluded from a formulary, all other drugs are included, but negotiated downstream prices are lower due to the threat of being the one drug excluded from the formulary. While this stylized model may understate the costs of formulary exclusion in practice, since more and more drugs are being excluded (e.g. Agha et al. (2020)) it does provide a rationale for how negotiated formularies deliver value.

In addition, the authors show that another rationale for why PBMs exist is that they internalize a contracting externality. The authors posit that most-favored nation contracts are common in the contracts between PBMs and manufacturers: as a result, many smaller PBMs are less efficient as a collective at extracting rents from manufacturers than several large PBMs would be. Coupled with other potential organizational efficiencies related to bargaining and scale, this paper presents a number of reasons for why having larger PBMs could be beneficial for overall welfare and for consumer welfare.

In another recent working paper, Olssen and Demirer (2021) studies formulary placement as a function of negotiated drug rebates off list price for Medicare Part D insurers. In their setup, drug manufacturer negotiates with insurers and offers higher rebates in return for placement on preferred tiers, delivering more customers to the manufacturer. While their mode encapsulates the key trade-off between formulary design and drug costs it doesn't actively consider the strategic role of PBMs as an intermediary in between drug manufacturers and insurers.

Olssen and Demirer (2021) uses Medicare Part D data to estimate consumer demand for drugs and, subsequently, for health plans given what tiers those plans have placed drugs on. The paper focuses on the market for branded statins and uses estimates of consumer drug and plan preferences to back out bounds for upstream rebates with a model of manufacturer-insurer negotiations. The authors are agnostic about the particular form of upstream bargaining over rebates and instead use weaker restrictions to bound rebates. They estimate average rebates of approximately 37% for both branded drugs in this space (Lipitor and Crestor), though there is substantial heterogeneity in these rebates across insurer and across formulary tiers within insurer. They investigate several counterfactual analysis related to changing the equilibrium rebates they es-

timate (e.g. to bring total prices consistent with prices in Canada) and study the endogenous consequences for formulary tier placement and downstream drug consumption.

The demand model in Olssen and Demirer (2021) is a nice contribution to the literature on formularies and tiering that is important for studying the vertical supply chain for drugs. While Olssen and Demirer (2021) is the first paper we are aware of to perform this kind of sophisticated demand analysis in the context of the drug supply chain, there are quite a few other paper that model consumer demand for insurance plans as a function of formularies and subsequent downstream drug demand. While a survey of papers studying drug / insurer plan demand is beyond the scope of this paper, examples of recent papers in this space include Brot-Goldberg et al. (2021b), Decarolis et al. (2020),Ho et al. (2017), and Abaluck and Gruber (2016). Also, see Chandra et al. (2019) and Handel and Ho (2021) for broader surveys of the literature on insurance plan choice. There are also several recent papers that focus on how separate policies like copay coupons (Dafny et al. (2017)) and prior authorization restrictions by insurers (Brot-Goldberg et al. (2021a) impact drug demand. Though these papers don't focus on the vertical supply chain for drugs, they do discuss policy impacts on drug demand, which have potential implications for upstream behavior.

Finally, though not directly related to the vertical supply chain for drugs, there are a series of papers in the health care space that study provider or pharmacy network formation by insurers. Like those in the drug space discussed above, these papers also study discounts obtained from providers in return for preferred placement within an insurance plan (or placement within a plan at all). Ho (2009) and Ho and Lee (2017) study these issues in hospital markets, Grennan and Swanson (2020) study this in the market for hospital supplies and Starc and Swanson (2021) study this in relation to pharmacy inclusion in drug plan networks.

This summary of work to date provides some general insights into the state of the literature on PBMs and the vertical drug supply chain. A first key insight is that this literature is still relatively thin, despite the importance of understanding the key relevant interactions for drug supply policy. The current papers in the literature tackle important questions related to specific slices of the vertical supply chain. Several focus on drug manufacturer interactions, ignoring downstream interactions between PBMs and MCOs and MCOs and customers. Others focus on the downstream implications of manufacturer rebates and formulary inclusion, but don't investigate strategic interactions through the different links in the supply chain (e.g. PBM-insurer interactions and PBM-manufacturer interactions). Others (e.g. Conti et al. (2021) focus on providing rationales for why PBMs exist, using tools from organizational economics. However, none that we are aware of model the full vertical supply chain shown in Figure 3. Since each interaction in the vertical

supply chain is important, and there has been almost no emphasis on PBM-insurer interactions in the literature, it seems that a key step forward in the literature is a more complete model of the whole vertical supply chain that can shed light on policy impacts as they propogate through this supply chain in equilibrium. Why has the literature to date not focused on simultaneously modeling interactions throughout the vertical supply chain? There are likely several reasons. First, as discussed in Lee et al. (2021), constructing fully specified models of vertical industries is inherently complicated and often have substantial ambiguities when considering the equilibrium implications of certain policies. Given the almost non-existent literature on PBMs prior to the last decade, making incremental steps studying specific interactions along the supply chain has been a very sensible approach. As the role of PBMs has gained more policy attention and researchers have made progress studying vertical industries in general, a complete characterization of vertical interactions becomes more feasible. It is also important to note that most papers on vertical industries involve two levels of firms and downstream consumers (e.g. Crawford and Yurukoglu (2012), Ho and Lee (2017)) while a full characterization of equilibrium for the drug supply chain involves interactions between three layers of business (manufacturers, PBMs, insurer) as well as downstream consumers. This makes the characterization and computation of equilibria inherently more complex.

In addition, data on interactions throughout the vertical supply chain for drugs has been quite limited in terms of researcher access. The rebates PBMs negotiate are highly proprietary and they protect the data on these rebates carefully since it is a prime potential source of competitive advantage. As a result, most empirical papers mentioned in this section don't have access to rebate data and instead, at best, have access to data on drug list prices, drug final consumer prices, and formulary inclusion / exclusion. While having these data components permits some useful analyses (as in Olssen and Demirer (2021)), it is difficult to model the role of PBMs in the vertical supply chain without detailed data on rebates, both in terms of (i) the rebate given by the drug manufacturer to the PBM and (ii) the portion of that rebate passed through to downstream insurers in formulary negotiations. These are key strategic variables determining the behavior and profit-making for manufacturers, PBMs, and insurers and they data have typically not been available to researchers.

In this next section, discussing the paths forward for future research on PBMs, we discuss both the potential for advances in modeling and the potential for access to more detailed data on manufacturer-PBM-insurer interactions. While the literature in this space is still young, progress on these two dimensions is crucial for leveraging economic analysis to inform key policy decisions related to drug supply.

3 Paths to Progress

This section discusses potential paths forward for researchers to make progress analyzing the implications of market structure and PBMs in the drug sector. First, we use our ongoing modeling work as an example of potential ways to enhance current research through applied theory. Next, we discuss potential avenues for improving the datasets researchers have access to for studying key relationships and outcomes in the drug sector.

3.1 Improved Modeling

One key potential path to better our understanding of behavior along the vertical supply chain for drug provision is to continue the path that the literature has focused on to date and construct careful models designed to capture how policy or market structure changes impact outcomes for all businesses in the supply chain and for downstream consumers.

To illustrate an example of the potential for economic modeling to improve our understanding of policy and market structures changes, we provide a broad overview of our recent work modeling the key strategic variables for the entire supply chain, including manufacturers, PBMs, insurers, and consumers (Brot-Goldberg et al. (2022)). In this ongoing work, we have set up an applied model of key actions in this sector, with an eye towards using the model in future empirical work. In that sense, we think that discussing this model here is useful as both an indicator of how research can progress on this dimension and also as a signal for what kinds of improved data may be needed to make progress on empirical research in this space.

Figure 4 presents a basic overview of the market structure we assume as well as the key strategic actions that agents take. The model is set up to apply to markets like Medicare Part D, where manufacturers, PBMs, and insurers all act as strategically motivated businesses along the vertical supply chain. The key interactions in the model are:

1. **Manufacturer-PBM interactions:** In the model we assume that there are two drug manufacturers who compete to have their drug included in a monopolist PBM formulary. The PBM and one of the manufacturers agree on a per-unit rebate per downstream drug purchase. In return, the PBM includes the drug on its formulary, which it then markets to insurers downstream. In the baseline case, the two drugs have the same average preference and symmetric heterogeneity relative to one another. Consumers can consume the excluded drug off-formulary at much higher cost downstream (we also

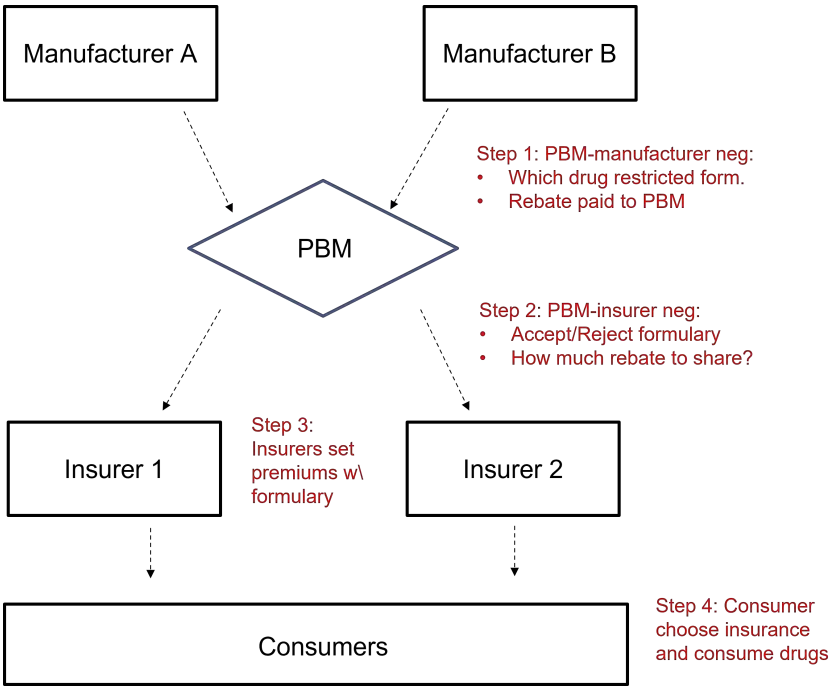

Figure 4: Basic overview of model in Brot-Goldberg et al. (2022).

examine cases where one drug is generally preferred over another by consumers).

2. **PBM-Insurer interactions:** Once the rebate the manufacturer gives to the PBM is set, we investigate PBM-insurer interactions. We begin with a baseline case where the PBMs and insurers are not integrated with one another. In that case, the PBM offers its restricted formulary with the one included drug, with a specific per-unit drug price, to one or both of two symmetric insurers downstream. The per-unit drug price will generally pass through only some portion of the rebate secured from the PBM by the manufacturer (who retains some portion of this as per-unit profit) and this pass through is determined by assuming that the PBM and the insurers have relationship-specific Nash bargaining weights that determine how they split the potential surplus from contracting. Using a Nash Equilibrium solution concept with Nash bargaining (a la Crawford and Yurukoglu (2012)), we model (i) whether the PBM offers the restricted formulary to one or both downstream insurers and (ii) whether zero, one or both insurers accept the PBMs offer. If they accept, they obtain the included drug at a lower per-unit price and their members can only purchase that drug under the insurer's cost-sharing scheme. In addition to this baseline case, we examine cases where certain insurers are preferred to one another (e.g. due to brand effects) and the case where one insurer is integrated with the PBM (which we discuss in more depth below.

3. **Insurer Competition:** Once the insurers have contracted with the PBM (or not) they compete with one another to attract consumers. Insurers have symmetric differentiation apart from drug formularies: consumers have the same average preference for the two insurers with symmetric heterogeneity (some consumers prefer one plan, other consumers prefer the other). With this setup, insurers choose premiums following a Nash Equilibrium. Consumers with heterogeneous preferences for the two possible drugs and preferences over money and insurer brands choose an insurer. If an insurer does not contract with the PBM, they offer both drugs to consumers on their formulary, at the drug list price.

4. **Consumer Drug Demand:** given their insurance plan, preference for drugs, and preference for money, consumers choose whether to consume a drug or not and, if they do consume a drug, which one to consume. If, all else equal, a consumer would pick drug A over drug B, but they consume drug B in equilibrium, e.g. because that is the only drug on their formulary, this generates an inefficiency where consumers don't get the drug they "should." Consumers benefit from lower drug costs for on-formulary drugs, both via lower cost-sharing for that drug and via their lower plan premiums.

We characterize the underlying environment with a series of fundamental parameters:

- Upstream manufacturer drug list prices and marginal costs
- Patient preferences for drug A, drug B, and no drug. This includes a paramaterization of how substitutable the two drugs are for one another.
- How sensitive are patients to losing money via higher vs. lower premiums?
- Bargaining leverage for the PBM relative to each insurer
- Bargaining leverage for the PBM relative to the drug manufacturer

We solve the model using tools from industrial organization and game theory, using backwards induction. First, we solve for consumer drug demand, given the plan they enroll in. Then, given drug demand and insurer premiums, we solve for which insurance plan consumers choose. Next, we determine what premium insurers charge in equilibrium, given their formulary and the rebate share received from the PBM, if any. Next, we determine what is the rebate share that the PBM passes through to the insurer, given the relative bargaining weights and the downstream implications of this rebate decision. Finally, in cases where we endogenize the upstream rebate R, the PBM and manufacture determine that rebate, taking as given all of

the above downstream actions. The solution concept solves for a Nash equilibrium at all stages, taking the subsequent downstream implications into account.

In Brot-Goldberg et al. (2022) we study comparative statics of key outcomes with respect to key underlying model micro-foundations (e.g. drug substitutability, insurer substitutability, insurer-PBM bargaining leverage). Here, to highlight the potential for this kind of framework to deliver meaningful policy insights, we focus on two specific policy scenarios:

1. **Vertical Integration:** As discussed at the beginning of this article, over the past decade there has been significant vertical integration between PBMs and insurers. This has been the subject of much policy debate, but there has been little rigorous analysis to support the many possible claims about the effects (positive or negative) of this integration on key market outcomes. We adapt the model to account for vertical integration by allowing for the PBM to merge with one insurer and have that combined entity internalize profits from both parts of the supply chain. The PBM can continue to contract with the other insurer, but takes into account the downstream implications of that contracting for its insurance profits.

2. **Formulary Inclusion Restrictions:** One potential regulation that policymakers will consider in regards to drug supply are restrictions to ensure a minimal standard of access to certain drugs. In our framework, this implies that, if a drug is excluded from an insurer-PBM formulary, that the insurer has to provide at least some minimal level of cost-sharing for the excluded drug at list price. We perform an analysis where we implement this restriction with different levels of aggressiveness and investigate how it impacts key outcomes.

3.1.1 Illustrative Results: Vertical Integration

Figure 5 illustrates one phase of the vertical industry game in our model, the interactions between insurers and the MCO. We present results highlighting how vertical integration impacts key outcomes, focusing on comparative statics and directional impacts. Figure 5 illustrates insurer and PBM payoffs under different strategies and the equilibrium that results, for a specific underlying parameterization of our key micro-foundations. This includes a parameterization of (i) consumer preference heterogeneity for each of the two drugs (ii) consumer preference heterogeneity for each of the two insurer brands (iii) consumer preference heterogeneity for money (iv) insurer-PBM-specific Nash Bargaining weights and (v) upstream drug list

Insurer and PBM Profits:
No Vertical Integration

		MCO 2 – PBM	
		Accept	Reject
MCO 1 – PBM	Accept	(0.200, 0.200, 0.063)	(0.210, 0.168, 0.033)
	Reject	(0.168, 0.210, 0.033)	(0.177, 0.177, 0.000)

Insurer and PBM Profits:
Vertical Integration

		MCO 2 – PBM	
		Accept	Reject
MCO 1 – PBM	Accept	(0.272, 0.189)	(0.244, 0.160)
	Reject	(0.208, 0.208)	(0.177, 0.177)

Figure 5: This figure illustrates the downstream equilibrium between competing insurers and the monopolist PBM. The top matrix shows payoffs contingent on whether or not 0,1, or 2 insurers accept the PBM formulary offer. The first two payoffs are profits for each insurer and the third payoff is for the PBM. The bottom matrix studies the case where insurer 1 and the PBM are vertically integrated. The first payoff is the combined profit for the insurer 1-PBM merged entity and the second payoff is the profit for MCO 2. The red squares indicate the equilibrium in each scenario, where the PBM offers the restricted formulary to both insurers (whether integrated or not) and both insurers accept the formulary. This analysis is for a specific parameterization of insurer-MCO bargaining power, consumer drug preferences, and consumer insurer preferences.

prices and marginal costs. Later, we discuss a few scenarios where we perform comparative statics with respect to these underlying micro-foundations.

The figure represents the downstream game played by the PBM and the two insurers, leveraging concepts from game theory. The game illustrated in the figure corresponds to the phase where the PBM makes an offer to one or both insurers that offers a restricted formulary with some reduced final drug price. Each insurer decides whether to accept or reject the formulary offer if given and the payoffs included in the matrices indicate profits for the insurers and the PBM in each scenario. These payoffs are determined by playing out the downstream game (not pictured) where insurers set premiums based on their formularies and consumers purchase insurance and consume drugs.

For the specific paramaterization studied, each insurer accepts the restricted formulary offer if it is offered to them. In turn, the PBM maximizes its profits by offering the restricted formularies to both insurers. So, the unique Nash equilibrium in this game is that the PBM offers the restricted formulary to each insurer

Insurer and PBM Premiums and Rebate Shares:
No Vertical Integration

		MCO 2 – PBM	
		Accept	Reject
MCO 1 – PBM	Accept	(1.096, 1.096, (0.338, 0.338))	(1.104, 1.538, (0.341, 0.000))
	Reject	(1.538, 1.104, (0.000, 0.341))	(1.546, 1.546, (0.000, 0.000))

Insurer and PBM Premiums and Rebate Shares:
Vertical Integration

		MCO 2 – PBM	
		Accept	Reject
MCO 1 – PBM	Accept	(1.055, 1.107, (0.307))	(1.026, 1.530)
	Reject	(1.578, 1.122, (0.314))	(1.546, 1.546)

Figure 6: This figure illustrates the downstream equilibrium between competing insurers and the monopolist PBM. The top matrix shows insurer premiums and rebate shares conditional on whether or not 0,1, or 2 insurers accept the PBM formulary offer. The first two entries are equilibrium insurer premiums, for each insurer, and the next two payoffs indicate the share of the rebate that the PBM passes through to each insurer. The bottom matrix studies the case where insurer 1 and the PBM are vertically integrated. The first two entries are still insurer downstream premiums while the third entry is the share of the rebate passed through to the non-integrated insurer 2. The red squares indicate the equilibrium in each scenario, where the PBM offers the restricted formulary to both insurers (whether integrated or not) and both insurers accept the formulary. This analysis is for a specific parameterization of insurer-MCO bargaining power, consumer drug preferences, and consumer insurer preferences.

and both insurers accept. The contracted drug costs, determined by how much of the manufacturer rebate the PBM passes through, is determined via Nash bargaining with each insurer.

The top part of Figure 5 investigates this for the case without vertical integration and the bottom part of the figure investigates this for the case with vertical integration, where we assume insurer 1 and the PBM are integrated. A few insights are clear when comparing the cases with and without vertical integration. First, the merged entity earns higher combined profits (about 4% higher, .272 vs .263) relative to the case where they are unintegrated. Second, profits for insurer 2 decline (5%), which we will learn momentarily is due to (i) receiving a lower per unit rebate than without VI and (ii) facing a competitor who can charge an even lower premium than before due to VI.

Figure 6 highlights other outcomes resulting from these PBM-insurer interactions. Comparing the top matrix (without VI) to the bottom matrix (with VI) shows that with vertical integration:

1. The premium for the integrated insurer decreases (by approximately 5%) while the premium for the non-integrated insurer increases (by 1%). This occurs because the PBM-insurer merged entity now internalizes the impact of passing through the drug rebate on downstream competition, leading to greater (full) pass through for the merged entity and lower pass through than before for the non-merged insurer.

2. Specifically, the merged insurer-PBM entity continues to offer the restricted formulary to the second insurer, but now offers it only a 30% share of the rebate instead of the 34% share it had offered previously when unintegrated. While the specific values depend on the underlying parameterization of micro-foundations discussed above, this examples illustrates that vertical integration can raise rivals costs, favoring the merged downstream insurer relative to its competitor. Another consequence is that the PBM retains a higher share of the rebate in profit, for the excluded insurer, relative to the unintegrated case.

Figure 7 illustrates how the vertical model can yield insights with comparative statics. The figure studies what happens when insurer bargaining power relative to the PBM changes. It studies the range of cases from where the insurer has almost no bargaining leverage in determining rebate pass through to the case where it has almost all of the bargaining leverage. To study the implications for vertical integration, we investigate the difference between key outcomes under vertical integration to the same outcomes without vertical integration, as a function of this underlying bargaining leverage.

The Figure yields several insights, given our underlying parametrization:

1. For the excluded insurer (from VI), the rise in insurance premiums due to vertical integration is always positive and is higher as insurer bargaining leverage increases (top right). This is because with higher insurer bargaining leverage, vertical integration causes the PBM to now internalize downstream insurer competition and the merged insurer to internalize PBM profits upstream. As a result, as insurer bargaining leverage goes up, the vertical merge has a bigger impact reducing insurer 2's effective market power and, consequently, the premium increase downstream due to VI is higher. The impact on the excluded insurer's profit (top left) is always negative, though it is most negative when insurer bargaining power is low and U-shaped as bargaining power increases.

2. Rebate pass through by the PBM to the excluded insurer is always smaller under vertical integration than without vertical integration. This negative change in pass through becomes larger in absolute

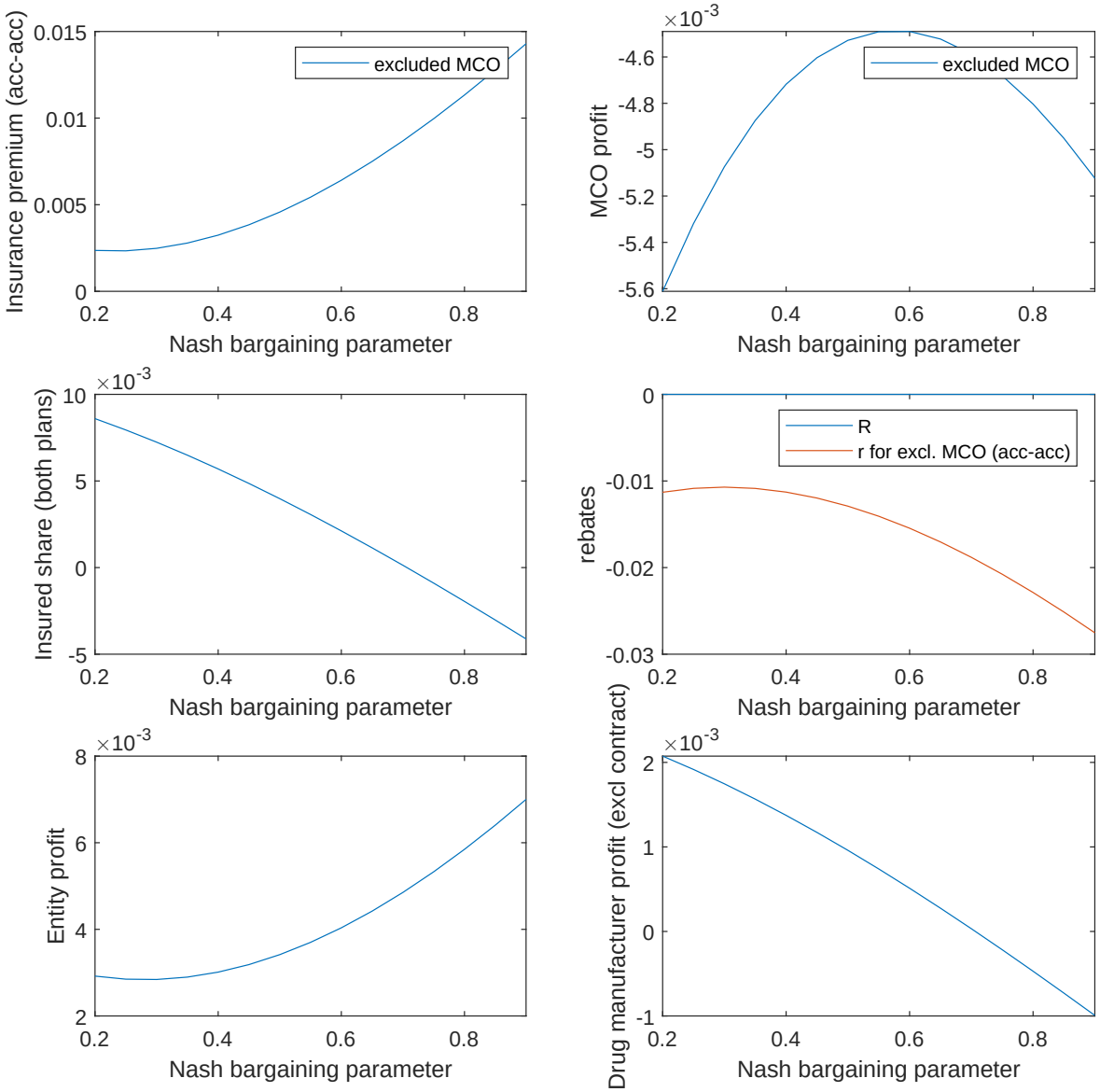

Figure 7: This figure illustrates comparative statics generated by the vertical model for key outcomes with respect to the underlying bargaining leverage of the MCO relative to the PBM. The x-axis in each figure is the bargaining leverage of the MCO: as we move to the right MCO leverage becomes stronger. The y-axis in each figures show the *difference* for each outcome in the case with vertical integration relative to the case without vertical integration. So, if the y-axis is positive that means that the quantity in question is larger with vertical integration than without.

value as insurer bargaining power increases, reflecting the bigger loss in effective market power for insurer 2 due to the vertical merger in that case.

3. With low insurer bargaining power, vertical integration leads to a greater downstream increase in overall insurer market share (relative to the outside option of being uninsured). This is because, when insurer bargaining leverage is low, the decrease in the downstream insurer premium for the merged insurer is larger, and brings more new consumers into the market. It is important to point out that, for low values of insurer bargaining leverage, vertical integration increase overall insurance market size, while for high values of insurer bargaining leverage vertical integration decreases insurance market size.

4. The total profit of the merged vertical entity due to vertical integration increases as insurer bargaining leverage is higher. By internalizing each other's incentives, the merged entity is able to extract more of the rents previously going to insurer 2.

5. Drug manufacturer profits are positively impacted by vertical integration when insurer bargaining leverage is low, and negatively impacted by VI when bargaining leverage is high. This mimics the discussion of insurance market share above: since the manufacturer rebate is very similar with and without VI under this parameterization, market expansion is good for the manufacturer and market contraction is bad.

While illustrative, this modeling framework highlights the subtlety of studying vertical integration in the PBM space. On the one hand, there are potential efficiencies to be gained when insurer bargaining power is low and the vertical merger reduces downstream insurer premiums for the merged entity, leading to insurance market expansion and cheaper final drug prices (leading to greater drug access relative to the non-integrated world). On the other hand, vertical integration hurts the excluded insurer, raising their costs and premiums and reducing their ability to compete. The simulations presented show a case where, if insurer bargaining leverage was initially high, vertical integration increases downstream insurance prices, increases drug costs, and limits drug access. This suggests that the specific micro-foundations estimated in each market is crucial for assessing the impacts of vertical integration on key market outcomes.

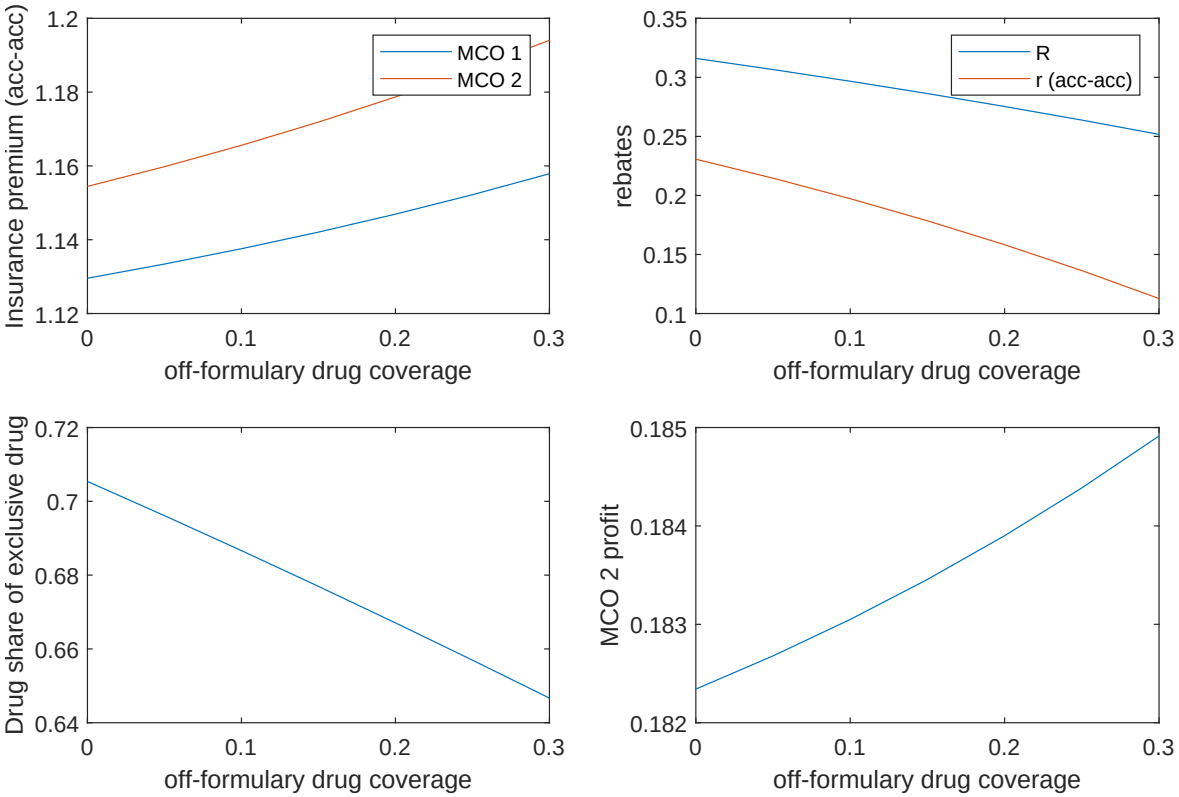

Figure 8: This figure illustrates comparative statics generated by the vertical model for key outcomes with respect to the strength of underlying regulation increasing drug access for consumers. The x-axis in each figure is the proportion of cost-sharing an insurer is required to cover for all drugs. The y-axis in each figure shows a given market outcome.

3.1.2 Illustrative Results: Access Regulation

One potential issue with restricted formularies is that some consumers may not have access to drugs that are beneficial to them. One potential oft-discussed policy response is to require that insurers provide some coverage for most/all drugs, including, e.g., those not on the restricted formulary if contracting with a PBM. However, the policy implications of this kind of regulation are subtle: requiring some degree of access will impact interactions throughout the entire vertical supply chain and the consequences of the regulation are thus a priori unclear.

We model access regulation as the percentage of cost-sharing that a given insurer is required to cover for a given drug. Figure 8 presents comparative statics as a function of the strength of this policy, ranging from 0 required coverage (baseline case) to 30% required coverage, i.e. the consumer is responsible for 30% of the list price. This increases consumer insurance for cases where they have a strong preference for a drug not included on the formulary.

The analysis yields several insights. First, it shows that as access regulations become stronger, insurer premiums increase. This is due to the fact that insurers are being required to cover a greater percentage of costs for off-formulary drugs, and those costs are spread to the entire pool of insured consumers through premiums.

Second, the rebate the manufacturer supplies to the PBM, as well as the rebate passed through to the insurer, both decrease as off-formulary access regulation strengthens. This occurs because stronger off-formulary access requirements weaken the bargaining position of PBMs relative to drug manufacturers and drug manufacturers are able to take back some of the surplus as a result.

Third, the shares of the drug included in the exclusive PBM contract decreases as off-formulary access increases. This occurs because off-formulary access to the competitor drug is now cheaper for consumers, making it a closer substitute. Fourth, the profit of the excluded insurer increases as access regulation strengthens. While this seems counter-intutitive, it occurs because requiring some off-formulary drug coverage actually allows the insurer to grant greater access to the excluded drug than the PBM permits in our model, where they offer an all-or-nothing formulary. It will be important to assess in practice whether access regulation can help insurers obtain preferred results by redefining the potential contracting space with PBMs.

Taken together, this analysis illustrates how an economic model of the complete vertical drug supply chain can be used to assess subtle implications of a policy like access regulation. We now turn to a discussion of how improved data quality and data access is crucial for unlocking the potential benefits of this kind of modeling for empirical analysis.

3.2 Improved Data

While continued modeling progress is an important path forward in this space, perhaps the biggest impediment to constructive empirical work is data availability. While data on formularies, final prices, and list prices are readily available for markets like Medicare Part D, the data on rebates, and particularly on rebate shares kept by the PBM vs. passed through to insurers downstream, has generally been unavailable at the insurer-PBM level. Access to granular data like this is especially important for understanding the strategic positioning and strategic interactions of industry participants.

While researchers haven't had access to "ideal" data there has been some progress for researchers learning about average rebates for specific drugs. Specifically, recent work by Kakani et al. (2020) uses data

from SSR Health to quantify how average rebates at the drug level have changed over time. They find that, relative to list prices, average rebates increased from 32% to 48% between 2012 and 2017 and that this overall pattern was relatively consistent across drug classes. They show that annual inflation of list prices was 12% while that of net prices was 3%, suggesting that, as expected, a nuanced understanding of net prices is essential for understanding drug market outcomes in the U.S. This paper makes excellent progress in improving our understanding of average rebates at the drug level, across all payers and all markets in the United States.

This is a nice start, but doesn't yet deliver the kind of detail needed to effectively understand strategic relationships in the vertical supply chain. It is possible, and even very likely, that proprietary datasets exist, either in the pharmacy industry or with regulators, that has the same rebate data by drug broken down at the payer-market level. Assembling and accessing these kind of data should be an essential goal for researchers going forward and could open up empirical works that effectively leverages the kind of vertical market model described above to deliver exciting and impactful policy conclusions.

4 Final Thoughts

Prescription drug costs have risen rapidly over the past decade and policymakers are currently grappling with how to control drug costs while also ensuring that consumers have access to the drugs that they need. A lot of discussion has centered around the role played by Pharmacy Benefit Managers (PBMs) who act as intermediaries in between drug manufacturers and insurers. By negotiating restricted formularies in return for drug discounts (rebates), PBMs have the potential to generate value through selective contracting. However, the PBM sector has high market concentration, leading some to posit that PBMs unproductively leverage their market power to capture rents from consumers, insurers and drug manufacturers.

Economic and policy analysis of PBMs to date has been limited in large part because effectively analyzing them requires (i) a precise model of the vertical supply chain and (ii) improved data on the micro-level interactions between insurers, PBMs, and drug manufacturers. This paper has tried to illustrate that advances in modeling are clearly possible, with significant potential for delivering value if paired with detailed complementary data. The illustrative model we presented studied the implications of vertical integration and the implications of drug access regulation, and could be used / modified to study the implications of other oft-discussed policies as well. While the implications of such policies are subtle, given the many relation-

ships and interactions throughout the drug supply chain, when paired with detailed data researchers should be able to use economic models to deliver clear and impactful policy insights.

While access to the data required may be tricky and challenging, having policymakers identifying this data access as a key obstacle to effective policy analysis may spur both data collection and dissemination. Though making such data publicly available should be discussed carefully, in the context of the kind of supply model discussed here, at a minimum such data should be made available to policy analysts and researchers on a restricted basis in order to better understand how policies related to drug cost and consumption impact key outcomes and propagate through the supply chain.

Economists have made significant progress implementing empirical studies of vertical industries over the past decade. Better modeling and better data have been the two key ingredients for moving analyses in these other sectors (e.g., hospital markets, media markets, medical device markets) forward. With so much at stake to consumers, producers and regulators, similar progress studying vertical relationships in drug supply can and will have a huge impact on drug provision and regulation moving forward.

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